AD NUMBER

AD221761

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; Jun 1956. Other requests shall be referred to US Naval Civil Engineering Research and Evaluaition Lab., Port Hueneme, CA.

AUTHORITY

US Naval Construction Battalion Ctr ltr dtd 24 Oct 1974

(1)

Project NY 300 010-1
Technical Note N-277
27 June 1956

AD 221761

VENTILATION SYSTEM PROTECTION AGAINST BW AEROSOLS

by W. R. Nehlsen

621 000

U. S. Naval Civil Engineering Research and Evaluation Laboratory
Port Hueneme, California

SUMMARY

Practical passive defense measures against biological warfare aerosols are required to be economical, and every available means must be explored. Since many buildings are equipped with air-handling and filtering equipment that may offer some degree of BW defense, ventilation air filters and air-supply system components ~~have~~ been tested with 0- to 5-micron-size dust, DOP smoke, and a BW simulant organism to assess the protection available against BW aerosols. Results show that a high percentage of particles below three microns in diameter will penetrate an air-conditioning system equipped with panel-type ventilation air filters. During a one-hour BW aerosol test on a ~~NAVCERELAB~~ test shelter, an 80-per cent penetration of the air-conditioning system was experienced, but the aerosol concentration inside the shelter only reached a level of about 50 per cent of the outside concentration because of recirculation and dilution. This degree of protection is too low to be of much practical value for BW defense.

The dust test results are valuable for providing information for the application of panel-type ventilation filters as prefilters for collective protectors. Technical Note N-287 shows the complete dust test results.

INTRODUCTION

Attack with a biological aerosol is probably the most insidious of the potential weapons available for CBR warfare. Absolute protection against the intrusion of particles of bacterial or other agents is so expensive that it will only be available to very essential facilities. The potential of this weapon is so great that a practical protection method for all Naval Base buildings must be devised. Bureau of Yards and Docks Project NY 300 010-1, "Test and Evaluation of Commercial Air Filters and Mechanical Air Systems" established a program of development to determine the basic and application information necessary to improve the BW protection ability of ventilation systems for buildings. This report is an evaluation of the results of tests on air filters and air system components using dust and smoke as BW aerosol simulants. Confirmatory tests with bacteria spores were performed by a Camp Detrick test group.

The most important BW protective device in a mechanical air system is the air filter; therefore, the major effort of this project has been directed toward low cost filtering equipment. Because there are very many types and brands of ventilation air filters, the test program was designed to assess the value of all these filters. Since limited aerosol removal occurs in other elements of an air system, tests were conducted on various components such as cooling coils and air washers. Results of the test program are indicated in the section on DOP smoke tests.

Although several other types of filters were tested, this report is based on the results obtained with what is most commonly known as the panel-type ventilation air filter. Panel-type filters are much more widely used than any other type, and special construction would be required to adapt these other types to existing installations. Other types of filters tested included several configurations of glass wool, or paper of various thicknesses folded into a frame to give a large filtering area and low face velocities. Some of these gave very good results, but they are too expensive to purchase and operate in normal ventilation systems.

DUST TESTS

Tests were conducted to determine the ability of all available brands of panel-type filters to remove the Oto 5-micron size test dust from an air stream. Arrestance and resistance values for each filter were determined over a wide range of air velocities with the filters clean. The results of these tests were used to select approximately twenty filters for a second group of tests on arrestance and resistance using filters that had become loaded with a commercial test dust. The results of the clean filter tests and filter-loading tests are reported in detail in Technical Memorandum M-099 and Technical Note N-287.

Figure 1 shows the performance curve of a 2-in. thick, clean, unoiled fiber glass filter; the filter that had the best arrestance of the panel types, while clean, but had a very low dust-holding capacity. Figure 2 shows the results of the loading test using a 2-in. metal viscous impingement filter, which had a very good dust retention capacity but a lower arrestance ability than the glass-type filter illustrated in Figure 1. The obvious way of improving the effectiveness of these filters is to combine them and the results in a very good sustained arrestance with a moderate dust retention capacity before excessive resistance developed. The second curve in Figure 3 is included to show the performance of a 4-in. metal viscous impingement filter which showed the best combination of arrestance and dust retention of all the single filters tested. The 4-in. metal filter was operated at 518 fpm and the combination of metal and fiber glass was operated at 346 fpm for best results. The results indicated in Figure 1 are believed to be the optimum that can be obtained with a single panel-type filter or a combination of this type.

SMOKE TESTS

Although the dust used in the tests just described was selected to give results nearly parallel to an expected biological aerosol, the limitations of the method did not allow determination of arrestance information on subgroups of the 0- to 5-micron particle-size dust used. Since information on these subgroups is essential for a good evaluation of BW protection, a series of tests with DOP Smoke were made at NAVCERELAB by Naval Research Laboratory personnel. Size fractionation was accomplished by use of jet impactors in the sampling system, and readings were made with an NRL smoke penetrometer, which utilizes the light-scattering properties of small particles to assess aerosol concentrations.

Three filters were tested by this method to cover the range of results obtained by the dust tests. These were clean filters which had shown low, medium, and high arrestances of dust. The results (see Figure 4) confirmed those indicated for the dust tests: the filter which performed best on dust performed best on smoke. Significantly, even the best filters captured only a small percentage of particles with a diameter of less than three microns. Only on particles of at least five microns in diameter was the arrestance substantial.

Smoke tests were also made on many elements of an air-conditioning system, such as blowers, and heating and cooling coils. The results indicate that there is considerable retention of particles in the 5- to 10-micron size range in blowers and coils, but that most of the smaller particles were carried through the system. The arrestance of micron-size particles by ventilation equipment other than the filters is best considered as of secondary importance.

DISCUSSION OF TEST RESULTS

The accumulated data on filter and air-system performance under many conditions points clearly to the limitations of the ventilation air filters and air-system components as a BW protection device. None of the panel-type filters could remove more than about 60 per cent by weight of the test dust over a reasonable period of time. The smoke tests (see Figure 4) indicate that almost 100-per cent penetration of these filters would occur if the aerosol was in the one-micron size range. Confirmation of these general results was obtained with biological aerosol tests described in the following section.

AIR-SUPPLY SYSTEM BW EVALUATION

As a final test to measure the BW aerosol protection that might be obtained with a ventilation system using panel-type air filters, a test building equipped with a typical air-supply system was exposed to a BW aerosol by Camp Detrick test personnel, and aerosol penetration was measured.

For this test the air supply system was operated at 1200 cfm of air in a 20,000 cu ft test room. The 1200 cfm consisted of 900 cfm recirculated air and 300 cfm fresh air. The elements of the air system were a mixing plenum into which the fresh and recirculated air were ducted; a 20- by 20-in. air filter made up of a 2-in. metal viscous impingement filter and a 2-in. unoiled glass wool filter making a 4-in.-thick filter with a pressure drop of 0.20 inches, a blower and approximately 40 feet of duct work, a heating coil operated with 150 F water, and a spray-type air washer equipped with a recirculating water pump.

The test aerosol was generated for one hour outside the fresh-air inlet so that 300 cfm of contaminated air was being induced into the mixing plenum. From the mixing plenum the combined fresh and recirculated air were carried through the air-supply system to the test room.

The over-all result of the one-hour test indicated that about 80 per cent of the aerosol in the plenum was carried into the test room, and that the aerosol concentration in the room reached approximately the same aerosol concentration as was in the mixing plenum. The net effect is a very low degree of protection, and the inside concentration reached about half that on the outside.

CONCLUSIONS

Results of several different groups of tests have shown that panel-type filters and typical air-supply system components offer a low degree of protection against BW aerosols. Particles of around three microns and lower are not removed by these devices, but the use of panel filters as pre-filters for collective protectors will provide a substantial reduction of the dust load on the collective protector filters. The best types of filters operating on dust will remove 50- to 60-per cent of typical particles of about 3- to 4-micron size and 90 per cent or more of particles measuring over 5 microns in diameter.

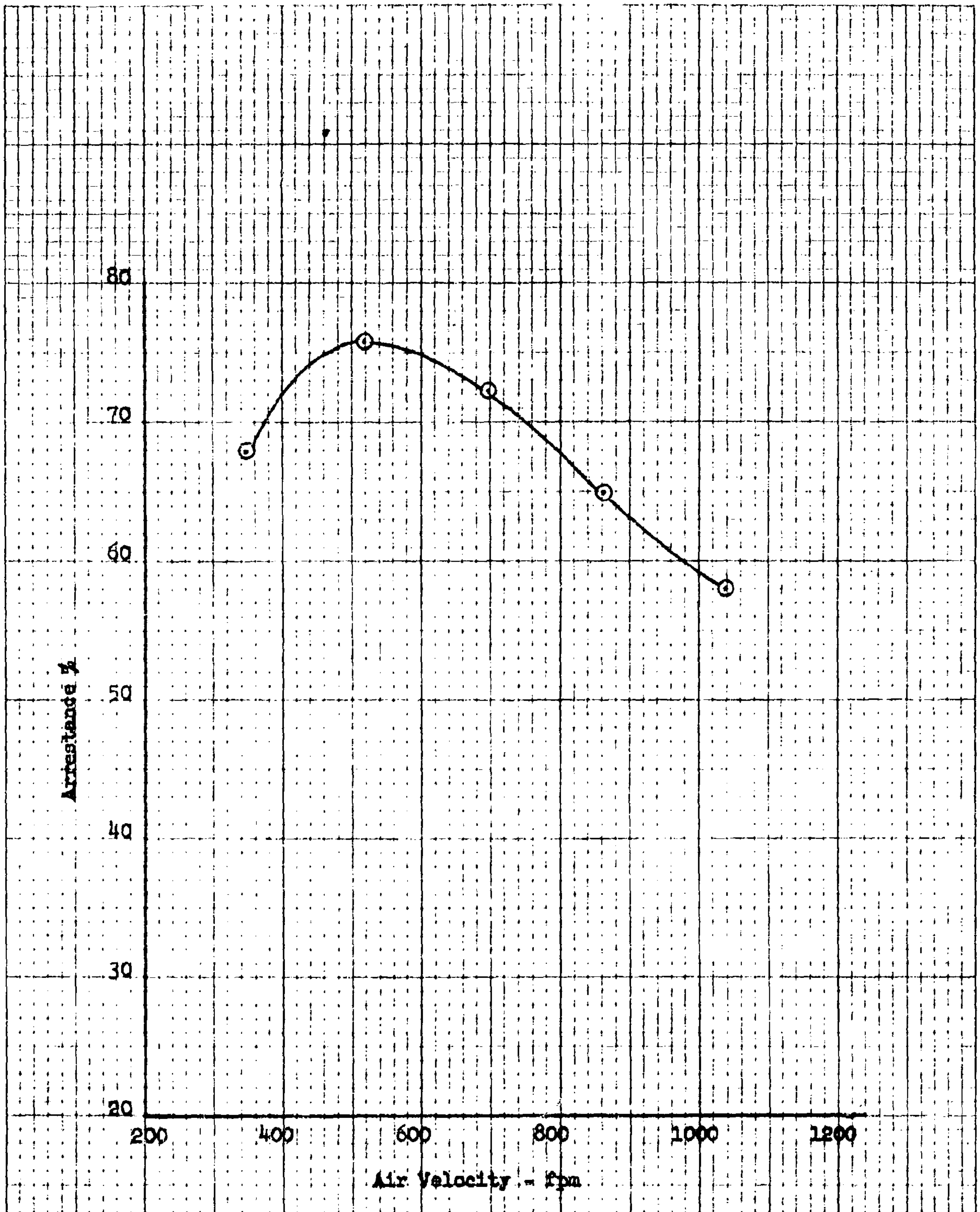

Figure 1. Performance of a two-inch thick, clean, unoiled fiber glass filter at various velocities.

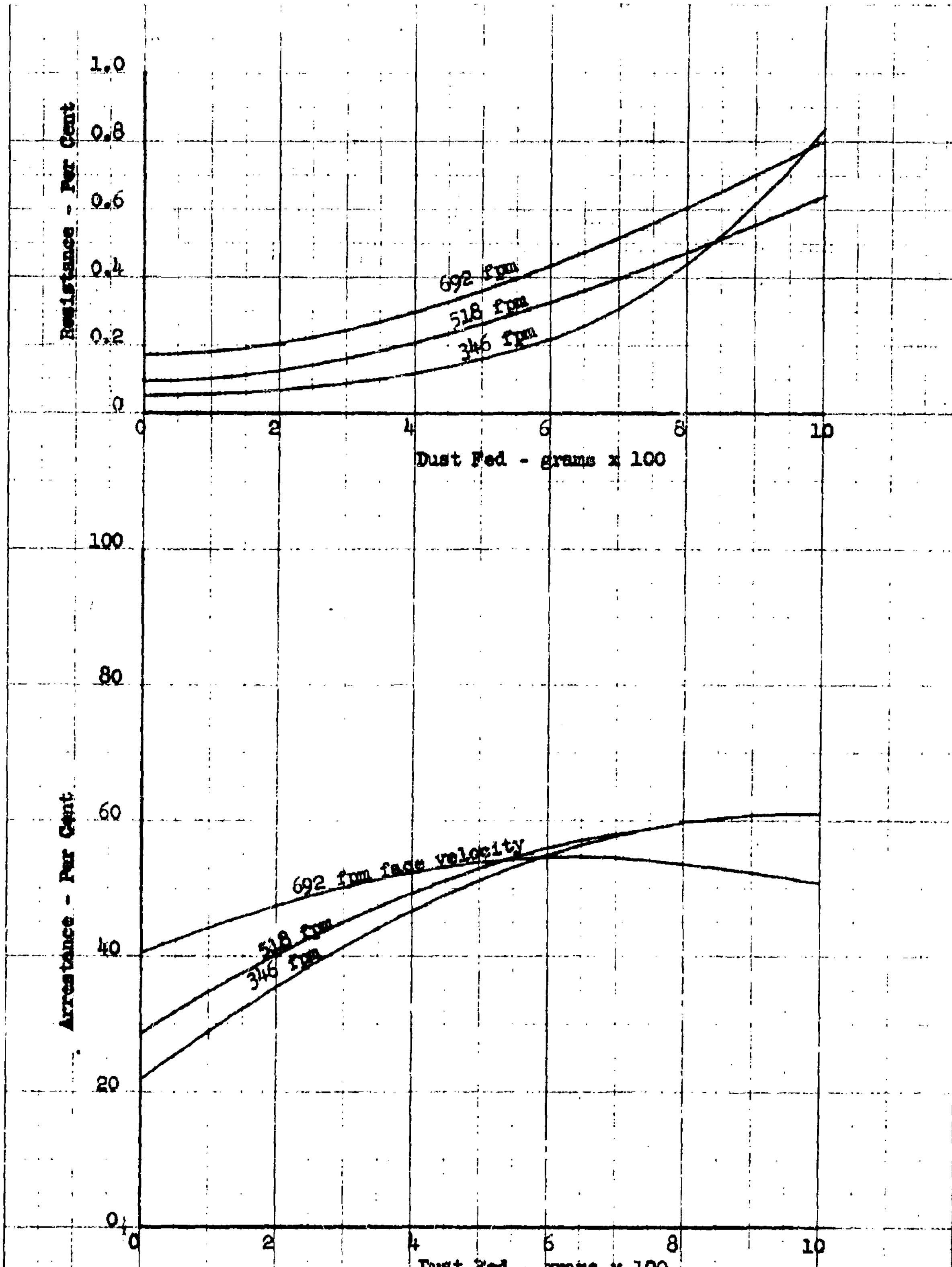

Figure 2. Two-inch thick, metal, viscous impingement filter dust loading test.

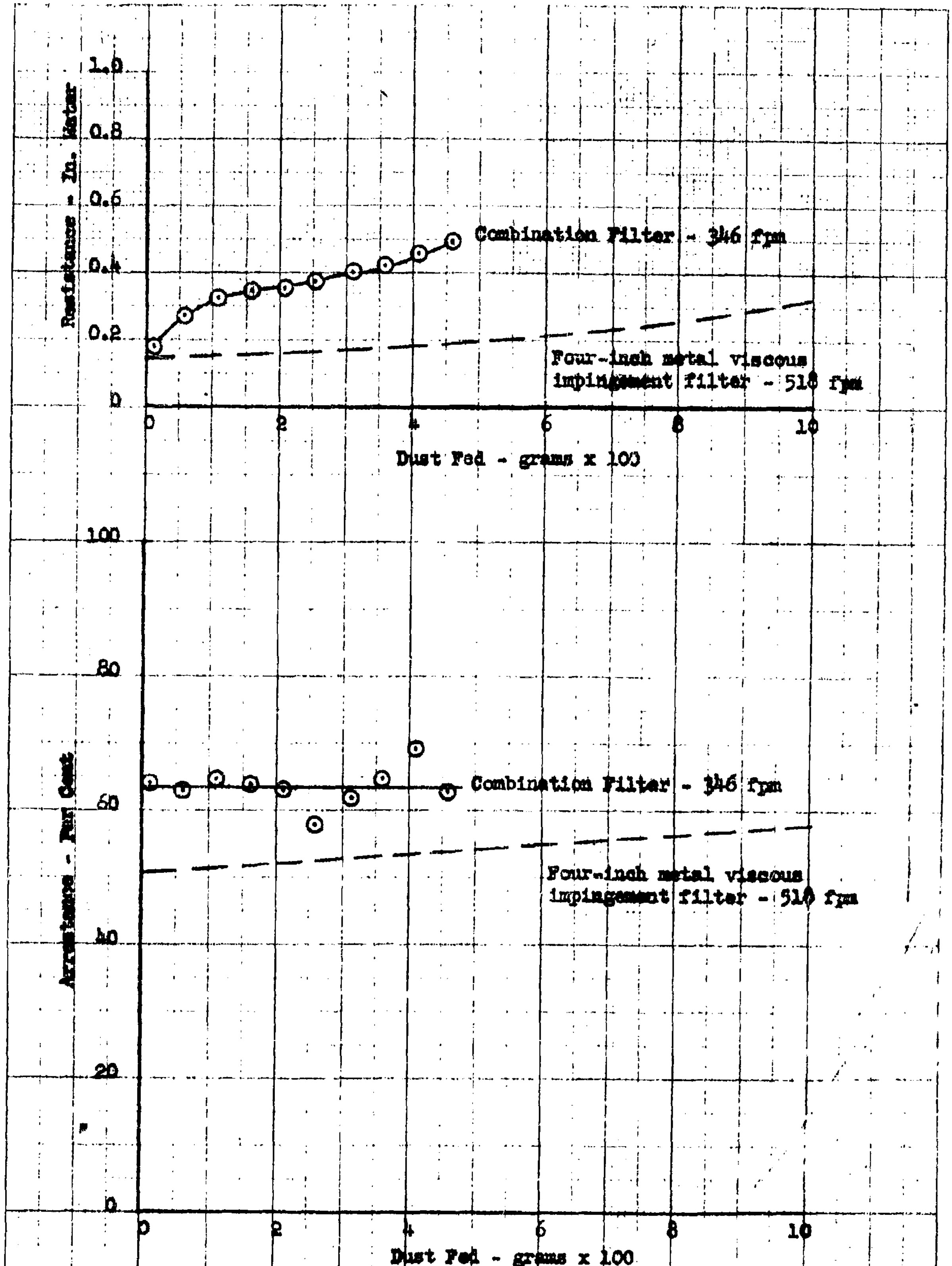

Figure 3. Loading tests of a combination filter and a four-inch filter.

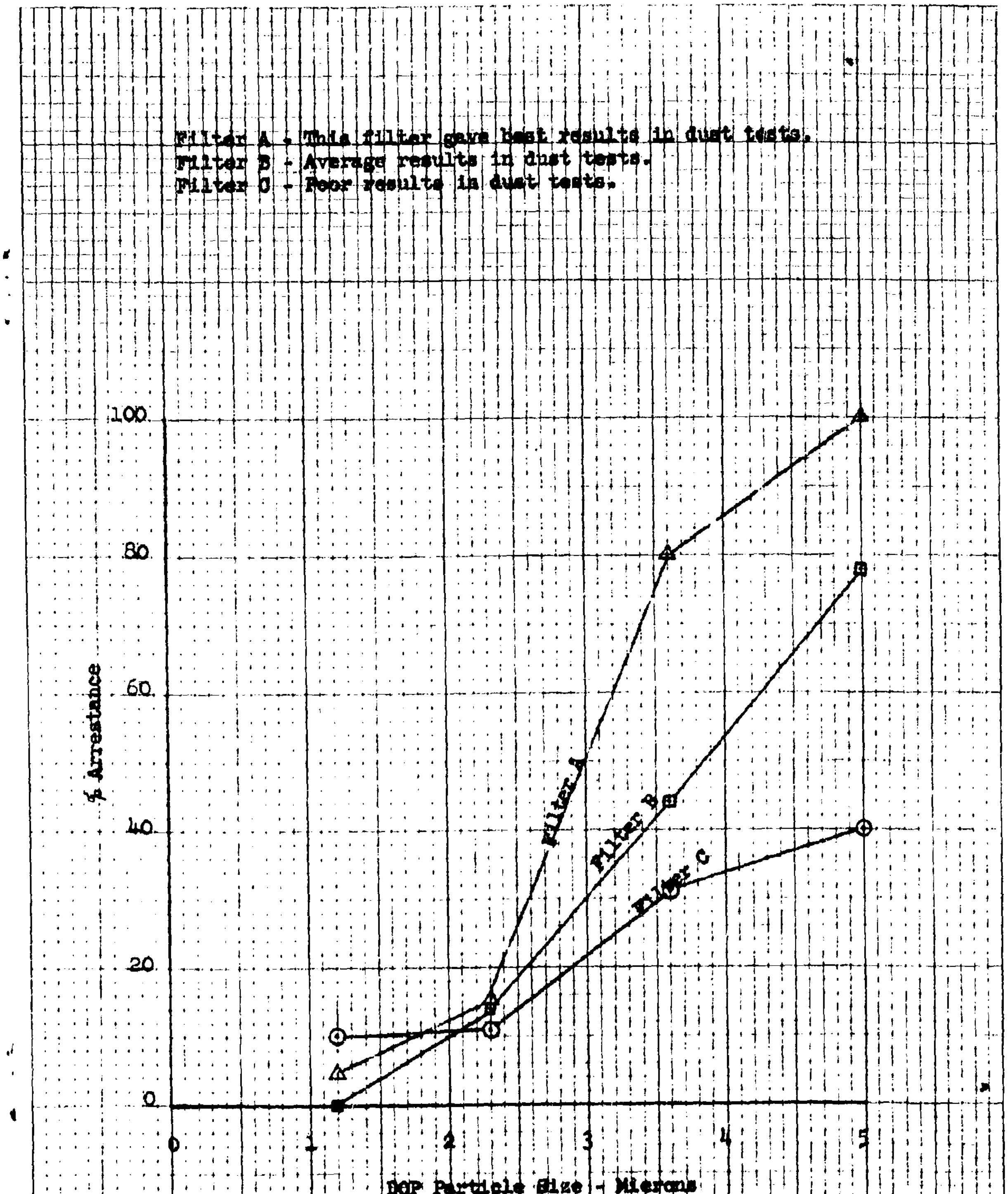

Figure 4. Effectiveness of the best, average, and poorest performing filters on DOP smoke particles of 1 to 5 micron diameters.